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Western Juniper Log Debarking Project

by Larry Swan and Scott Leavengood

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Final Report

Western Juniper Log Debarking Project

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Western Juniper Debarking Project

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Abstract

The vast majority (approximately 80-90 percent) of western juniper trees are unsuitable for saw logs (Swan personal communication). Markets for fiber and other products must be pursued to economically harvest and process juniper on a large-scale. One potential market for juniper is as chips for hardboard and medium-density fiberboard. These products generally require a bark content of less than three percent.

The stringy and fibrous nature of western juniper bark, as well as log form, concern many in industry who have considered chipping juniper. A common belief is that juniper cannot be debarked effectively or efficiently with existing sawmill or "in-the-woods" debarkers. The purpose of this project was to gather information about the effectiveness and economic efficiency of commonly available debarking equipment on western juniper. This information will assist chip producers and sawmills analyze and select the most economical and efficient method for their particular operation and markets.

Three different types of debarkers were used in these trials: Ring, chain flail, and rosserhead. A total of about 90 logs were run through three ring debarkers at two different mills, about 10 logs were run through a chain flail, and about 19 logs were run through two different rosserheads at two different mills.

Contrary to common industry belief, all three types of debarkers performed effectively on juniper logs. Bark content of chips averaged below two percent, well within industry standards for such fiber products as hardboard and medium-density fiber board. Economic efficiency is another issue. If a mill does not already have a ring or rosserhead debarker installed, end-product market price range (such as chips) and costs of getting the product to market, must be closely examined. Portable mills probably will not be able to justify the capital investment for debarkers. For "in-the-woods" operations, chain flail debarkers also operate effectively and economically on western juniper.

Purpose

The purpose of this project was to gather information about the effectiveness and economic efficiency of commonly available debarking equipment on western juniper (*Juniperus occidentalis*). Results will provide chip producers and sawmills information to guide analysis of the most economical and efficient method for a particular operation and markets.

Need

The vast majority (approximately 80-90 percent) of western juniper trees are unsuitable for saw logs (Swan personal communication). Markets for fiber and other products must be explored to economically harvest and process juniper on a large-scale. One potential market for western juniper is as chips for hardboard and medium-density fiberboard. The manufacturing processes for these types of fiber product generally require chips with three percent or less bark content, which appeared obtainable based on anecdotal evidence from "in-the-woods" chipping operations using chain flails.

Not all primary producers use chain flails, and many who do are not convinced that the bark content of juniper chips can be reduced to under three percent. Sawmills especially, indicated concern about debarking juniper, and putting the stringy and fibrous bark into their residual processing system. Some specific concerns cited include:

- Effectiveness of commonly-available debarkers (such as ring debarkers) on asymmetrical, limby logs with high taper;
- Down time due to equipment plugging; and
- Increased potential for fires starting in residue grinding ("hogging") equipment.

Existing large mills, which commonly have ring debarkers, and a few individuals who are contemplating increasing their production of juniper lumber, are looking for options and information to increase the value of their residue. In-the-woods chipping operations are also interested.

Background

This project was formulated and designed by members of the Western Juniper Commercialization Steering Committee, a loosely-organized cooperative venture of the U.S. Forest Service, Wood Products Competitiveness Corporation, Inc. (WPCC), and Oregon State University Extension. Steering Committee membership is composed of wood products industry representatives (small, medium and large companies), government agencies, non-profit economic development and environmental organizations, and private landowners.

An Oregon Multi-Region Program grant proposal was prepared and submitted to the Governor of Oregon in the fall of 1994, and approved in April, 1995 (Swan 1996). Industry and community interest was so high that work began in January, 1995, four months before the project received official notification that lottery funding was approved. The final debarker test was completed in February, 1997.

Prior Work

A literature review was conducted prior to the project to determine if there had been previous work concerning the effectiveness and economic efficiency of different debarking equipment on western juniper. No relevant citations were found. Literature citations and discussions with industry indicated that species with similar bark, such as incense-cedar, western redcedar, redwood, and cypress are often debarked with rosserhead debarkers (Figure 1). While this type of debarking equipment is often slower than ring debarkers and sensitive to operator skill-levels, it reportedly works well on species with stringy or fibrous bark. Some manufacturers in the redwood and western redcedar industry have also used hydraulic debarkers (debarking using high-pressure water spray). The use of hydraulic debarking equipment though, has declined in recent years with the increasing concerns for water quality.

Eastern redcedar (*Juniperus virginiana*), a very similar species to western juniper, is not commonly debarked. Industry participants in tours of eastern redcedar producers in Missouri, sponsored by the U.S. Forest Service in 1994 and 1996, did not observe and could not recall anyone even mentioning debarking prior to primary processing (Leavengood and Swan 1994).

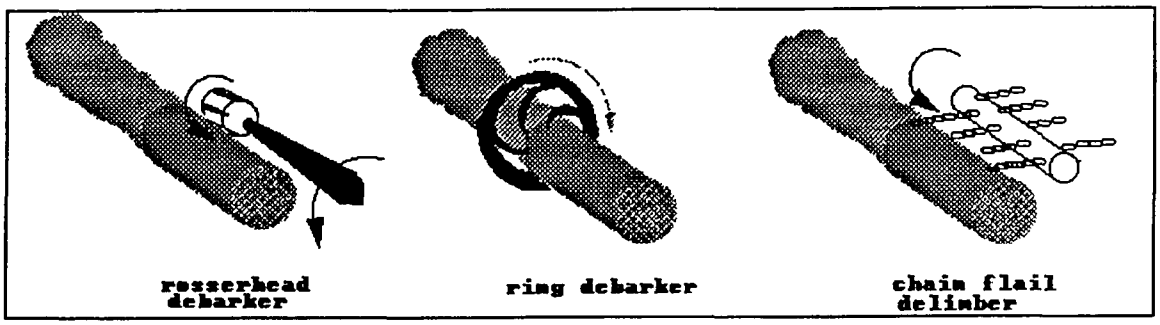

Figure 1. Debarking equipment used in the project

Current Practices

Most western juniper primary manufacturers do not debark their logs since production is small (averaging less than 1,200 board feet per day when running), erratic, and focused on sawn material rather than chips. Slab wood is simply thrown away or used for firewood, rather than chipped or made into hog fuel. Only one mill which has a production history including juniper is known to run a debarker, and that one was just recently installed (Morbark rosserhead).

The reason the one company (High Desert Wood Products, Dairy, Oregon) decided to install a debarker was to increase the value of their mill residue; a nearby hardboard plant is willing to accept juniper chips, but wants bark content less than three percent[1]. The mill replaced a hammer hog with a chipper and debarker to improve the economics of their operation: The price paid for chips in the Klamath Falls area as of February, 1997, was about $50 to $55 per Bone Dry Ton; the price paid for hog fuel was about $18 per Bone Dry Ton, if you could find someone who would even take it (Breedlove personal communication).

Methodology

Three different types of debarkers were used in the trials: Ring, chain flail, and rosserhead. Project completion was delayed almost a year due to difficulties in coordinating a fresh supply of juniper logs and an operating chain flail, and finding a rosserhead debarker (the only one within a 200-mile radius was finally purchased and put into operating condition by High Desert Wood Products, Dairy in January, 1997).

Ring Debarker Trials

On January 27, 1995, 37 western juniper logs from Lake County, Oregon, were debarked at Modoc Lumber in Klamath Falls, Oregon. Logs averaged eight to ten-feet in length, with large-end diameters averaging 18- to 25-inches and small end diameters averaging 10- to 14-inches. The majority of the logs were 90 to 100 years old and came from an area where scattered juniper dominate the overstory. Logs were limbed with a combination of chainsaws and shears, which scraped-off lower limbs if the butt swell was not too great. Logs were somewhat larger than those normally harvested for saw logs, but were generally of "poor quality": Rapid taper, large and numerous knots, and numerous bark seams. There was, however, less butt rot than normally encountered. Logs were frozen when debarked (for more information about the logs, see Appendix A, *Field Notes of Debarking Trials*).

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[1] For comparison, chips from undebarked juniper logs have a bark content of seven percent or more. If slabs from the milling process are are chipped, bark content averages more than ten percent (Swan personal communication).

Two types of ring debarkers were used: A 27-inch Salem and 50-inch Salem. No special care or operational changes were prescribed. Most of the logs were run through the 27-inch Salem, simply because of their size and length. A sample of debarking residue was obtained and evaluated for bark versus wood content, as well as bark content of chipped residue resulting from the next day's operation when the debarked logs were processed into lumber. Weyerhaeuser Hardboard Division, Klamath Falls, conducted both analyses.

On March 25, 1996, about 55 logs from Modoc County, California, were debarked using a 27-inch Salem at Klamath Veneer in Klamath Falls, Oregon. Logs averaged 24- to 26-feet in length, with large-end diameters averaging 14- to 24-inches and small-end diameters averaging four- to six-inches. The majority of the logs were between 80 and 90 years old and were reported to come from the same mixed-conifer stand. Logs were limbed with chainsaws and appeared to be higher quality than those normally harvested for saw logs: Knots averaged two- to three-inches in diameter and were spaced six- to 12-inches apart. Very little butt rot was observed and there were fewer bark seams than normal. Logs were frozen when debarked (for more information about the logs, see Appendix A, *Field Notes of Debarking Trials*). No analyses were conducted of debarking residue or chips.

Chain Flail Debarker Trial

On October 21, 1996, about 12 green juniper logs were debarked by Circle DE Lumber, Klamath Falls, using a Peterson Pacific, Model 4800 chain flail delimber. Logs averaged 24-feet in length, with large-end diameters averaging 14-inches and small-end diameters averaging four- to six-inches. The majority of the logs were between 80 and 90 years old and obtained from a medium to dense juniper stand near Bonanza, Oregon (average density ranged from 50 to 150 trees per acre). Logs were delimbed using either a CTR or Danzco pull-through mechanical delimber. Logs were very similar to those used in the Klamath Veneer ring debarker trial (see above). Logs were not frozen when debarked (for more information about the logs, see Appendix A, *Field Notes of Debarking Trials*).

A small sample of chips from the debarked logs was analyzed by Collins Products, Klamath Falls Hardboard Division, which during the course of the debarking project had bought-out Weyerhaeuser Klamath Falls operations. The same personnel performed the tests and the same techniques were used.

Rosserhead Debarker Trials

Two rosserhead debarkers were used for the debarking trials: A 1960s-era Sherman at Modoc Lumber and a more recent Morbark Model C24.

Only a couple of logs were put through the Sherman Rosserhead at Modoc Lumber. This was done in conjunction with the ring debarking trials on January 26, 1996 (see log description above). The mill used the rosserhead primarily for logs too large or with too much butt swell or sweep to be debarked by the 50-inch Salem ring debarker. The mill manager reported that they "touched-up" the rosserhead by building-up the cutting surface with welding material prior to the trials. Residue from the rosserhead was collected and analyzed by Weyerhaeuser Hardboard Division.

On February 5, 1997, 17 green juniper log segments were debarked using a recently-installed Morbark Rosserhead Model C24 at High Desert Wood Products, Dairy, Oregon. Log segments averaged 16-feet in length, with large-end diameters averaging 14-inches and small-end diameters averaging four- to six-inches. The majority of the logs were between 80 and 90 years old and obtained from a medium-density juniper stand

near Bonanza, Oregon (50 to 100 juniper trees per acre). Logs were delimbed using a CTR pull-through mechanical delimber. Logs were not as good of quality as those used in the Klamath Veneer ring debarker or Circle De chain flail trials (see above): They were less symmetrical, and had numerous large knot-swells and "pigs ears" (short branch staubs which were not cut flush with the log surface). Logs were frozen when debarked (for more information about the logs, see Appendix A, *Field Notes of Debarking Trials*).

A small sample of chips from the debarked logs was analyzed by Collins Products, Klamath Falls Hardboard Division, at the same time chips from the chain flail test were analyzed.

Results

Ring Debarker Trials

No significant difficulties were encountered at Modoc Lumber with either of the two sizes of ring debarkers (27- and 50-inch Salems). Industry observers present during the debarking trials expressed surprise that the logs debarked as well as they did. Some mentioned the possibility that since the logs were frozen, that bark broke off in "chunks" versus being peeled off in long strands. Debarking residue did not support this hypothesis. Because of the lack of hold-downs for short logs, the juniper logs appeared to bounce around significantly more in the 50-inch Salem versus the 27-inch Salem. Two "passes" were used to debark logs with the large ring vs. one pass with the smaller ring. The average time per eight- to ten-foot log through the small ring was between 20 to 25 seconds.

Operators of both the large and small ring debarkers ran their machines slightly slower than normal. Both operators mentioned that they were taking more time due to having an audience as well as working with an unfamiliar species. The ring debarkers both produced very long (six- to eight-inches) "slivers" of bark and wood.

Weyerhaeuser Hardboard in Klamath Falls analyzed the debarking residue and chips made from the logs debarked:

- Debarking Residue: Approximately 70 percent bark and 30 percent wood.
- Chip Bark Content: Two to three percent.

Minor difficulties were experienced during the ring-debarker trial at Klamath Veneer. The operator had to stop the machine occasionally to unplug and untangle long strips of bark from the tool arms. Logs were also shorter than normal and were not as effectively held-down during debarking. Debarking time was similar to white fir, ponderosa pine and lodgepole pine. The operator stated that the logs debarked in strips like incense-cedar, though not as thick. The debarked residue was diverted away from the normal hog fuel system because it was too long for the hammer hog grates. The grates have since been modified and would accept this material (Breedlove personal communication). The mill manager commented that the logs debarked well and, based on experience, guessed that were the logs chipped, bark content would be three percent or less. Wood loss did not appear excessive.

Chain Flail Debarker Trial

No significant challenges occurred during the chain flail debarker trial. Processing time through the debarker

averaged 18-19 seconds. The chipping operation supervisor commented that debarking effectiveness could be improved if "pigs ears" were eliminated (short branch staubs which were not completely removed during mechanical delimbing). He estimated chip bark content at approximately two percent (Blaylock personal communication). Analysis performed by Collins Products, Klamath Falls Hardboard Division, on a small sample of chips made from these logs yielded 1.4 percent bark content.

Rosserhead Debarker Trials

The Modoc Lumber Sherman rosserhead debarker appeared to remove bark more effectively than the ring debarkers, however the trade-off was in time: Each eight- to ten-foot log required approximately five minutes. One side-benefit was that irregularities were eliminated, offering a more symmetrical log with fewer protrusions which could hang it up while being further processed. The residue from this machine was ground very fine. Surprisingly, bark versus wood content was nearly identical to the ring debarkers: About 70 percent bark and 30 percent wood.

The Morbark rosserhead debarker trial at High Desert Wood Products was conducted immediately following installation. At first, it did not appear to remove bark as effectively as the Sherman rosserhead, but average times were about a quarter (average 78 seconds) of those recorded at Modoc Lumber (five minutes). Log lengths were similar. It was estimated by the High Desert Wood Products operator that about 60-70 percent of the bark was removed during these initial "shake-down" trials.

Debarking effectiveness and speed improved after a few equipment modifications were made and the operator had a couple of days of experience. Equipment was modified to increase "hold-down" and decrease space between side posts (reduce incidence of logs coming out of rollers and requiring hand-repositioning). Improved operator experience was also a significant factor. Logs appeared to bounce around more than those processed at Modoc Lumber, even after equipment modifications were made.

It was estimated that about 75 to 80 percent of the bark was being removed by the Morbark Rosserhead at the end of the initial "shake-down" trials (versus 60 to 70 percent at the beginning); debarking times decreased from an average of 78 seconds to an average of 40 to 50 seconds per log. The time necessary to debark juniper after initial "shake-down" trials was comparable to the time necessary to debark pine and fir logs (about 30-40 seconds per 16-foot log). Analysis performed by Collins Products, Klamath Falls Hardboard Division, on a small sample of chips made from these logs yielded 1.6 percent bark content. Analysis of rosserhead residue yielded a figure of 96 percent bark and 4 percent wood.

Discussion

See Table A , *Rough Comparisons of Three Debarkers Used in Juniper Debarking Trials*, for crude comparisons of key advantages and disadvantages of the three types of debarkers used for these trials.

Ring Debarker

Ring debarkers performed effectively, with few of the problems predicted by many in industry. Bark content of chips averaged two to three percent, well within the acceptable range of fiber products such as hardboard. Some equipment plugging was encountered in one trial, but no more than the operator expected, based on his experience with incense cedar. Production was similar to pine and fir, and not significantly affected by time spent unplugging bark from the tool arms (production was about 60 24-foot logs per hour, or about 1,440

linear feet per hour, assuming an average large-end diameter of 14-18 inches). Some modification of the log transport system and hold-downs may be needed, given shorter lengths and less symmetry than normal commercial species. A minor increase in maintenance costs is expected, due to increased vibration caused by shorter, asymmetrical logs bouncing around.

According to one industry source, used ring debarkers range from $15,000-$30,000. Installation costs are in the same range. Installation costs are high due to substantial footings and reinforced structure necessary for a ring debarker. Operations costs are assumed slightly higher than a rosserhead like the one tested, due to increased power requirements.

Chain Flail Debarker

In Eastern Oregon, chain flail debarkers are normally used in high production "in-the-woods" chipping operations. The Peterson Pacific model used for this trial performed well. Bark content of chips was expected to be around two percent. Actual measured bark content was 1.4 percent. Production averaged about 18 to 19 seconds per 24- to 26-foot log. Realistically, this translates to about 140 logs per hour, or 3,640 linear feet, assuming an average large-end diameter of 14-18 inches. The tops of approximately 10 percent or more of the logs run through the chain flail were broken, resulting in a small decrease in fiber recovery. Production figures are within the range predicted by a company sales representative (60 to 85 tons per hour) (Walker personal communication).

According to a company sales representative (Walker personal communication), costs of a used Peterson Pacific Model 4800 ranges between $50,000 and $140,000. A new one costs around $197,000. Operation and maintenance costs can be significant: Replacement chain costs about $800, and given the nature of juniper, might require replacement every four to six days (Blaylock personal communication). An operator and small "shovel" are necessary to feed and deck logs.

Rosserhead

The Morbark rosserhead used in these trials at first did not appear to clean juniper logs as well as an older-model Sherman, but was at least 75% faster. Bark content of chips produced from these logs though, averaged 1.6 percent. Some equipment modification is needed to make the Morbark perform more effectively. According to High Desert Wood Products, planned changes include: More knobs on the press rolls; additional spring on the press rolls; metal "slope sheet" to provide lift over the cutter head mounting brackets (will reduce incidents where "pigs ears" catch on it); one additional press roll on top and underneath; and additional posts to stop shorter logs from bouncing out of the feeding system.

Morbark rosserhead production increased about 20% between initial "shake-down" trials at High Desert Wood Products and just a few days later. Most of this increase was attributed to a few equipment modifications and additional operator experience. Another 20% increase in production is expected once all modifications are completed. Production after initial "shake-down" trials was about 40 seconds per 16-foot log, or about 90 logs per hour (approximately 1,140 linear feet per hour, assuming a large-end diameter of 14-18 inches) (McGee personal communication). This is about 75 percent of the production rate predicted by a company sales representative for normal commercial species (25-feet per minute) (Wark personal communication).

According to a company sales representative (Wark personal communication), costs of a used Morbark

Rosserhead (model C24) is around $20,000. A new Morbark Rosserhead (Model C24), with electric motors, is around $45,000. Installation costs will run $5,000 to $10,000 (McGee personal communication). Operation costs are expected to be somewhat less than a ring debarker, given lower power demand.

One indirect effect of a Rosserhead is that juniper log asymmetry is reduced, and projections which might hang-up on processing equipment in the mill are almost eliminated. This appears to result in a production increase of about 10 percent, as measured on the green chain (McGee personal communication).

Recommendations

Contrary to industry opinion before the trials, a variety of debarkers work fine with juniper. Effectiveness, as measured by bark content of chips, was within the range of raw material needs for hardboard, and possibly medium-density fiberboard (less than three percent bark content).

Economic efficiency is another question. Key questions include:

- Are there local markets available for juniper chips (within a 100 mi. radius)?;
- What is the projected range of chip prices over the next couple of years?; and
- Is there sufficient residue produced to make a debarker and chipper economically viable?

For example, a small, portable mill with production of around 1,000 board feet per day would have a hard time justifying a debarker at today's chip prices, even if someone else bought their residue and chip markets were available. On the other hand, if a small- to medium-size mill (5,000-30,000 board feet per day production) had a local market available and could live with the projected fluctuations in chip prices over a one- to three-year cycle, then a debarker and chipper might make sense. This is especially so if residue was previously going to the hog fuel market, which in the Klamath Falls area for example, was about $18 per bone dry ton, versus current prices for chips which is between $50 to $55 per bone dry ton.

"In-the-woods" chipping operations have different requirements, due to high production needs. If juniper is a minor component of overall production, there is no reason it cannot be separated, debarked and chipped. The reason for separating species is that at least in the Klamath Falls market area, buyers prefer to buy truckloads of all one species or another, in order to better control production quality and standards.

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Table A: Rough Comparisons of Three Debarkers Used in Juniper Debarking Trials

Rough Comparisons of Three Debarkers in Juniper Debarking Trials						
Debarker Type	**Used Cost Range**	**Installation Cost Range**	**Operation Costs or Needs**	**Maintenance Costs or Needs**	**Production**	**Results**
Salem 27" Ring	$15,000-$30,000	$15,000-$30,000	One operator; somewhat greater power costs than Morbark Rosserhead.	Normal; may be some plugging; need to tighten-up bolts and check welds regularly due to vibration.	Approx. 60 24'-26' logs/hr. (approx. 1,440 linear ft./hr.).	Chip Bark Content = 2-3%; Debarker Residue = 70% bark/30% wood.
Peterson Pacific Mod. 4800	$50,000-$140,000	N/A	One small heel-boom & operator.	Similar to chipping "dead wood"; $800 for replacement chains every 4-6 days;	Approx. 140 24'-26' logs/hr. (approx. 3,640 linear ft./hr.).	Chip Bark Content = 2-3%; Debarker residue not analyzed; 10% or more of tops broken during handling.
Morbark Rosserhead Mod. C24	$20,000	$5,000-$10,000	One operator;	Normal; need to tighten-up bolts and check welds regularly due to increased vibration.	Approx. 90 16' logs/hr. (approx. 1,440 linear ft./hr.).	Chip Bark Content = 2-3%; Debarker Residue = 96% bark/4% wood; Reduces asymmetry of juniper log and smooths irregularities which might hang-up in processing; one operator is seeing 10% increase in production.

APPENDIX A

Field Notes of Debarking Trials

Rough Notes

Rosserhead Western Juniper Preliminary Debarking Trials
High Desert Wood Products, Dairy, Oregon
February 5, 1997

Notetaker/Observations:	Larry Swan
Rosserhead:	Morbark Model C24
Price New:	$45,000 (approximately), with electric motors
Price Used:	$10,000 - $20,000
Installation Costs:	$5,000 - $10,000
Number of Observations:	17
Log Length:	16' and under
Log Diameters:	Avg. 14" large end and 4-6" small end.
Log Prep.:	Delimbed with CTR Pull-Through Mechanical Delimber
Wood Condition:	Frozen
Documentation:	Unedited Hi-8 video and 35 mm prints;
Operator Experience:	Limited; significantly improved performance after a couple of days practice. Learned to move bottom rolls at same time as run debarker.
Equipment Modification:	Day after observations were taken, put more knobs on front top press roll, installed another post to prevent shorter logs (10') from coming out of rollers, and installed metal "slope sheet" to provide lift over the cutter head mounting bracket (reduced incidents where "pigs ears" would catch). Plan on putting another spring on press rolls to keep logs down on debarker cutter and installing another post. Also thinking about an additional press roll inside and underneath, to help log turn better (raise with an air bag). Especially needed for logs greater than 16" in diameter (large end). Could then do logs up to 27".
Average Time:	About 78 sec. each log, after deleting first four observations (operator had to manually reposition log with a cant hook, which added significant time). After equipment modifications and additional operator experience, estimate that out of 40-45 juniper logs debarked the next day, only had to hand re-position 3-4 (less than 10% instead of the 30% plus recorded on video). Estimate with improved operator experience and equipment modification, times improved at least 20%. Instead of 70-80 sec., closer to 40-50 sec./log segment. Probably now closer to average of pine and fir, which is 30 ft./min., or about 30 sec./16' log. About half of improvement due to operator experience and half to equipment modifications. Expect to get another 20% improvement with planned modifications.

Rosserhead Western Juniper Debarking Trials - Cont.

	Thought that it might improve performance to start with the butt end first, so would not hang up on the pigs ears. Did not significantly add to performance when tried.
	Manufacturer's rep. said average speed of this model was about 25 ft./min. Original design specs. are for logs 4" to 24" diameters, and up to 25 ft. in length.
Bark Removed:	Appeared to remove about 60-70% initially. With modifications and additional experience, appear to be removing 75-80% of the bark. Still finding it difficult to get the bark out of the seams.
Indirect Effects:	Delimber produces significantly better log for processing in the mill. Do not have rough spots on logs and is more symmetrical. Probably seeing 10% increase in productivity. Also seeing reduction in maintenance. Ring debarker would not do as well.
Operator Preference:	According to Walt McGee, he would still prefer a ring debarker over the rosserhead. Ring debarker would cost more though and require significantly more installation time and expense. "Lots of concrete needed" for ring debarker, according to Walt. Estimated cost of used ring debarker = $15,000 - $30,000. Estimated cost of installation = $15,000 - $30,000.
Residue:	96% bark/4% wood.
Chip Bark Content:	1.6%